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SCHOOL OF SCIENCES AND HEALTH PROFESSIONS  
OLD DOMINION UNIVERSITY  
NORFOLK, VIRGINIA

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INTERDISCIPLINARY STUDY OF ATMOSPHERIC PROCESSES AND  
CONSTITUENTS OF THE MID-ATLANTIC COASTAL REGION

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*By*

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**ANNUAL PROGRESS REPORT**

**June 1, 1975 - May 31, 1976**

**NASA Grant NGL 47-003-067**

**INTERDISCIPLINARY STUDY OF ATMOSPHERIC PROCESSES AND  
CONSTITUENTS OF THE MID-ATLANTIC COASTAL REGION**

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**May 28, 1976**

## I. Review of Past Year's Performance

### 1. General

The past year was the first year of the reduced step phase and except for the elimination of the Marine Interaction Effort, the program proceeded much according to plan.

### 2. Field Experiments and Data Set Collection

(a) Two major field experiments were conducted during this period:

1) Analysis of the Air Quality of Plymouth Park, Chesapeake, Virginia. This study was accomplished in conjunction with the NASA Langley Research Center Particulate Measurement Van at the request of the State Air Pollution Control Board. The study was needed to update the particulate emissions from an industrial complex along the South Branch of the Elizabeth River. The final report was submitted to the State Air Pollution Control Board and a copy is being forwarded under separate cover.

2) Background Analysis and Impact Assessment for the Proposed Expansion of Busch Gardens. This study was required to determine if a permit for the proposed expansion of Busch Gardens would be issued. It was the first impact analysis in the state for such an installation under the new E.P.A. "Complex Source" requirement. The final report was forwarded to both the State Air Pollution Control Board and Busch Gardens and a copy is being forwarded under separate cover.

(b) The complete fixed location laboratory at ODU that will permit integration of field data and complete other isolated

input from SAPCB reporting sites is 90% complete and will be operating by 1 August 1976.

### 3. Application of Remote Sensing and Atmospheric Interaction

During the 1975-76 academic year, we attacked one major problem, one minor problem, and began work on a second major problem. The first major problem was a study of the influence of surface reflectance on Gaussian smoke plume diffusion models. A bounce parameter was introduced and its influence on plume geometry and maximum surface concentration were assessed. Two methods of extracting the bounce parameter from plume geometry were developed. The first involves viewing the plume laterally from the ground level in the cross wind direction, and a lidar study is proposed to apply the method to real plumes. The second involves viewing the plume vertically from above using aerial photography densitometrically analyzed, or digital data from a satellite (e.g. LANDSAT) image. A least squares fit algorithm to the transcendental geometric functions was developed that extends previous work (Cf. 4th Remote Sensing Conference, Tennessee, March 1975) to include the surface bounce parameter. A paper describing the lateral problem is being readied for publication, with one on the vertical problem expected to be submitted this summer.

The minor problem involved a study of the particulate effluent from the Union Camp Paper Company in Franklin, Virginia. At the request of the Virginia State Air Pollution Control Board, we analyzed data acquired by Union Camp over a three year period

at various sites around the city of Franklin. The analysis involved correlation of air quality readings to wind direction in order to establish the level of particulate background as opposed to the level of pollution caused by the company. Two oral presentations of the findings were made - one to the VSAPCB Region Six officials, and the other to the Virginia Academy of Science Meeting, May 1975, Harrisonburg, Virginia.

The major problem just beginning is a Masters Degree thesis study by Ms. Patimat Sadujew of instrument correlations between air quality monitoring devices of the Air Pollution Control Board in Region Six (Tidewater, Virginia). We have acquired on magnetic tape, all air quality data collected in the state since the establishment of the Board. Coefficient of haze and high volume air sampler readings will be correlated with each other to determine the reliability and significance of each device. Then autocorrelation functions will be run on each data record to determine episode frequency, and a correlation will be made to certain meteorological parameters, and between sites. The long range objective (which goes well beyond the work required for a Masters thesis) is to develop a statistical time series air quality model for Tidewater, Virginia, that can compliment the dynamical models currently being refined. This can increase the cost effectiveness of the state monitoring system by pointing out monitoring site redundancies, and by optimizing the utilization of limited monitoring resources.

#### 4. Biosphere Interaction Phase

In the step-down process of the program, this past year will terminate the Biosphere Interaction Phase. During this final year, emphasis has been placed on completing various projects under investigation. This goal was achieved in most cases. The primary exception was the study of terpene emission from various woody Dismal Swamp species which was terminated leaving many unanswered questions.

A total of four Master's theses were produced during the course of these investigations and one non-thesis research study. The theses include "Applications of Radiotracer Techniques to Transpiration Measurements of Spartina patens Grown Under Various Vapor Pressure Deficits," S. I. Stair (paper presented at meetings of the Virginia Academy of Sciences), "Measurement of Transpiration in Pinus taeda L. and Liquidambar styraciflua L. in a Closed Environmental Growth Chamber Using Tritiated Water," J. K. Czoch (paper presented at the meetings of the Virginia Academy of Sciences and M.S. submitted to Ecology), "The Use of Color Infra-red Aerial Photography in Determining Salt Marsh Vegetation and Delimiting Man-Made Structures of Lynnhaven Bay, Virginia," R. E. Holman III (published as a NASA paper) and "Application of Satellite Data and LARS' Data Processing Techniques to Mapping Vegetation of the Dismal Swamp," J. A. Messmore (papers presented at the Remote Sensing Conference and the Virginia Academy of Sciences meetings). The non-thesis research paper was, "A Study of the Effects of Light on the Emission of Terpenes from Certain Woody Plants," L. M. Coppedge (paper presented at the Virginia Academy of Sciences meetings).

5. Technical Reports Completed and Distributed (Copies forwarded under Separate Cover)

a) PGSTR-AP75-08

Data Set for Background Investigations of Atmospheric Constituents for Cape Henry Site, Kindle, Bandy, Copeland, et. al.

b) PGSTR-AP75-11

Plymouth Park, Chesapeake, Virginia, Air Quality Experiment, Copeland, Kindle, et. al.

c) PGSTR-AP75-14

Ambient Atmospheric Hydrocarbon Content as Determined by Gas Chromatographic Techniques for Rural Tidewater, Virginia, in Late Spring 1974, Copeland, Bandy, et. al.

d) PGSTR-AP75-15

Software for Digital Acquisition System and Application to Environmental Monitoring, Copeland

e) PGSTR-AP75-17

Impact Analysis Study of Busch Gardens, Kindle, Maier, Copeland

f) Interdisciplinary Investigations of Atmospheric Processes and Constituents of the Mid-Atlantic Coastal Region: Biospheric Interactions, Levy and Sonenshine

g) Application of Satellite Data and LARS' Data Processing Techniques to Mapping Vegetation of the Dismal Swamp, Messmore

6. Publications

Published

a) Blais, R. N., G. E. Copeland and T. H. Lerner, Use of LARS System for Quantitative Determination of Smoke Plume Lateral Diffusion Coefficients from ERTS Images of Virginia. In Remote Sensing of Earth Resources, v. IV, pp. 621-630, Editor, F. Shahrokhi, University of Tennessee Space Institute, 1975.

b) Messmore, J., G. E. Copeland, and G. F. Levy, Mapping Forest Vegetation with ERTS-1 MSS Data and Automatic Data Processing Techniques. In Remote Sensing of Earth Resources, v. IV, pp. 327-344, Editor, F. Shahrokhi, University of Tennessee Space Institute, 1975.



### Papers Submitted for Publication

- a) Copeland, G. E., R. Davis, P. Maroulis, A. R. Bandy, and R. Denyszyn, "Ambient Atmospheric Hydrocarbon Content as Determined by Gas Chromatographic Techniques for Rural Tidewater, Virginia, in Late Spring 1974," submitted to Environmental Science and Technology.

### Papers in Preparation

- a) Blais, R. N., "Influence of Surface Bounce on Gaussian Smoke Plume Diffusion Models," submitted to Atmospheric Environment, Pergamon Press.
- b) Copeland, G. E., "The Theory of the Electrostatically Charged Aerosol Plume," submitted to Applied Physics.

### 7. Undergraduate Student Independent Study Projects

T. J. Ciaffone, "Mapping of Cypress Zonation in the Great Dismal Swamp"

S. G. Sinkez, "Feasibility Study of Using Infra-red Aerial Photography to Detect Septic Tank Failures in Virginia Beach"

T. H. Lerner, "Calibration of a Thermal Infrared Scanner"

### Graduate Student Independent Study Projects

L. M. Coppedge, "A Study of the Effect of Light on the Emission of Terpenes from Certain Woody Plants"

### 8. Research Consultant Activity

- a) Remote sensing image analysis of plume dispersal from Yorktown power plant and oil refinery - for NASA Langley Research Center LIDAR group, prepared by T. H. Lerner and R. N. Blais
- b) Computer model for Yorktown carbon monoxide plume dispersal - for VSAPCB Region VI, prepared by G. E. Copeland
- c) Climatological study for Yorktown LIDAR plume study - for NASA Langley Research Center, prepared by R. N. Blais
- d) Computer model of particulate matter dispersal patterns from sources located on South Branch of the Elizabeth River, Norfolk, Virginia - for ODU Air Pollution Research Group, VSAPCB and NASA Langley Research Center

## II. Proposed Program for Academic Year 1976/77

### 1. General

This period, 1 June 1976 to 31 May 1977, will constitute the final year of the step-funded grant and will be directed primarily toward the following:

a) Fulfilling commitments to the State Air Pollution Control Board

b) Development of techniques to permit direct application of NASA LIDAR technology as well as passive sensing by aircraft and satellites to key air pollution problems.

c) Completion of data analysis and preparation of Final Progress Report.

### 2. Field Experiments

Three field experiments will be conducted during FY 1976/77, two in the summer of 1976 and one in the spring of 1977. These experiments have been coordinated with the State Air Pollution Control Board and are directed at key problem areas at this time. The first of these will be conducted in the Yorktown area, with primary objectives of measuring hydrocarbons, photochemical oxidants, and carbon monoxide.

The experiment to be conducted in June 1976 will support an investigation of the unexplained low concentration of carbon monoxide that has been generally noted and which seems to be far too low in view of the carbon monoxide emission rates that are given for the AMOCO Refinery. This will be coordinated with a

pattern definition of the total load of carbon monoxide as measured by a specially constructed airborne radiometer that has been developed by NASA. The experiment will serve not only to provide a pattern of the carbon monoxide distribution in the area of the refinery, but will also provide some guidance in checking out the accuracy of the airborne sensor.

The second field experiment will be conducted in August of 1976 at Northwest, Virginia, a location just to the southwest of the Great Dismal Swamp. This experiment will be conducted to assess the hydrocarbon and photochemical oxidant concentrations in a natural area to establish a background for the industrial area load of Hampton Roads. These results are needed to provide a more specific assessment of the impact of the proposed refinery in Portsmouth, Virginia.

The third experiment is tentatively scheduled to study particulates in the area to provide some background for E.P.A. required program to bring the Hampton Roads particulate loading within the national standards. The specific experiment will be defined in a joint meeting with the State Air Pollution Control Board in January 1977.

In addition to the above field experiment which samples selected sites for two three week periods, a longer record data set is needed to evaluate the field experiments in the context of the longer period seasonal and diurnal variability. Accordingly, the fixed station on the O.D.U. campus will be operated during the AY 1976/77. The results of this data set analysis will not only be used to provide a context for evaluation of remote location

short period experiments and to establish a long period data base, but will provide a background to assess the applicability of remote sensors (both airborne and satellite-borne passive systems as well as active LIDAR type systems).

### 3. Development of Capabilities to Apply Remote Sensing Techniques to Smoke Plumes

Work in the area will be concentrated on expanded techniques to use active sensors in refining understanding of smoke plume parameters which is badly needed to make pollution impact analysis through models more accurate. As stated in Section I, previous efforts have resulted in the development of a rationale for using a NASA developed LIDAR system to provide an assessment of the percent of pollutants that are reflected back into the atmosphere when plumes reach the earth's surface. At the present time, nearly all operational models assume a 100% reflection of the plumes which intersect the surface. This is probably a reasonable approximation over flat land surfaces or over water areas but over populated areas, this reflection is considerably less and over forested areas probably reduces to near zero. The LIDAR system through this approach promises to provide a means of introducing variable reflection percentages, for according to the type of surface underlying the plume, these could make a considerable difference in the model estimate of plume concentrations from proposed industrial installations.

This particular task element will be completed by August 1976 and will be provided to NASA researchers who are evaluating the use of the LIDAR.

The follow-on effort will be applied to developing a theoretical formulation to permit the allowance for LIDAR measurement of the plumes at oblique angles. This is necessary since the LIDAR can rarely be located on a line normal to a plume and the analysis of the data will require some calibration for the angle between the LIDAR signal and the axis of the plume.

### III. Proposed Budget

#### I. Personnel Costs

a. Summer 1976 - Dr. E. C. Kindle, Principle Investigator, 1 1/2 months \$ 5,117.00

Graduate Student 3 months @ \$500/month 1,500.00

Undergrad Student 12 weeks @ \$2.50/hour 1,200.00

b. Academic Year 1976/77

Dr. E. C. Kindle - 5% time 1,635.00

Graduate Student - 1/2 time 3,000.00

2 Undergrad Students - 1/4 time each 1,600.00

c. Summer 1977 - Dr. E. C. Kindle, Principle Investigator, 1/2 month 1,817.00

d. Secretarial Support 300.00

Total Personnel Costs \$16,169.00

INDIRECT COSTS 6,387.00

e. Consultant Programmer 2,400.00

f. Travel 600.00

g. Publications 400.00

h. Supplies 925.00

i. Computer 300.00

Less O.D.U. Contribution (Dr. Kindle's salary and indirect costs for AY 1976/1977) - 2,281.00

Total Required from NASA \$25,000.00